PRODUCTION OF VIRGIN COCONUT OIL (VCO) VIA WATER SOLUBLE MATERIALS AND CENTRIFUGATION METHOD

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ABSTRACT

The traditional ways of breaking Virgin Coconut Oil (VCO) using fermentation and heating are disadvantageous from both economic and environmental perspectives. In this study, the potentials of the water soluble, oil soluble materials that are environmentally friendly materials and centrifugation methods in demulsification of Virgin Coconut Oil (VCO). The effect of alcohols (methanol and ethanol) added to demulsification via water soluble material and centrifugation methods were also investigated. The study began with some characterization studies to provide understandings of fundamental issues such as formation, formulation and breaking of emulsions. The aim was to obtain optimized operating conditions as well as fundamental understanding of oil-in-water emulsion stability upon which further developing on demulsification process that could be developed. It was found that emulsion demulsification was related to some parameters such as water soluble concentration (0.5 v/v %), centrifugation speed (2,000 – 8,000 rpm) and processing time (30 – 90 minutes). Experimental results found that centrifugation method can enhance the demulsification in a very short time compared to the conventional fermentation method. The results obtained in this study have exposed the capability of centrifugation method in demulsification of Virgin Coconut Oil (VCO) emulsion. Further works are nevertheless required to provide deeper understanding of the mechanisms involved to facilitate the development of an optimum emulsion breaking system applicable to the industry.

Key words: Demulsification; O/W emulsion; Centrifuge; Virgin Coconut Oil (VCO); Separation

ABSTRAK

Cara-cara tradisional yang digunakan untuk menghasilkan Minyak Kelapa Dara (VCO) termasuk penapaian dan pemanasan merupakan satu kerugian dari perspektif ekonomi dan alam sekitar. Dalam kajian ini, potensi minyak bahan larut air, bahan larut minyak yang bersifat mesra alam sekitar dan kaedah centifukasi telah digunakan dalam demulsifikasi Minyak Kelapa Dara (VCO). Kesan penggunaan alcohol (metanol dan etanol) dalam proses demulsifikasi dengan bahan larut air dan centifukasi juga disiasat. Kajian ini bermula dengan beberapa kajian pencirian untuk memberi pendedahan dalam pemahaman isu-isu asas seperti pembentukan, penggubalan dan pemisahan emulsi. Tujuannya adalah untuk mendapatkan keadaan operasi optimum serta sebagai pemahaman asas terhadap kestabilan emulsi minyak dalam air untuk membangunkan lagi proses demulsifikasi. Ia mendapati bahawa beberapa parameter mamainkan peranan penting dalam demulsifikasi emulsi seperti kepekatan larut air (0.5 v/v %), kelajuan centifukasi (2000 – 8000 rpm) serta masa pemprosesan centifukasi (30 – 90 minit). Keputusan uji kajian mendapati bahawa kaedah centifukasi boleh meningkatkan kecekapan demulsifikasi dalam masa yang singkat berbanding dengan kaedah penapaian konvensional. Keputusan yang deperolehi dalam kajian ini telah mendedahkan keupayaan kaedah centifukasi dalam demulsifikasi emulsi Minyak Kelapa Dara (VCO). Kerja-kerja selanjutnya dekehendaki untul memberi kefahaman yang lebih mendalam mengenai mekanisme yang terlibat untuk memudahkan pembangunan dalam pemisahan system emulsi pada keadaan yang optimum untuk kegunaan industri.

Kata Kunci: Demulsifikasi; O/W emulsi; centifukasi; Minyak Kelapa Dara (VCO); Pengasingan

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LIST OF SYMBOLS

v_0	-	Settling Velocity
ρ_w	-	Water Density
ρ_o	-	Oil Density
r	-	Radius of Rotation
ω	-	Angular Velocity of Centrifugation
d	-	Diameter of Droplets
μ_w	-	Viscosity of Water Phase

LIST OF ABBREVIATIONS

APCC	-	Asia and Pacific Coconut Community
GC – MS	-	Gas Chromatography-Mass Spectrometer
HLB	-	Hydrophile – Lipophile Balance
MCT	-	Medium Chain Triglycerides
O/W	-	Oil-in-Water
TAG	-	Triacylgycerol
VCO	-	Virgin Coconut Oil
v/v	-	Volume / Volume Ratio
W/O	-	Water-in-Oil

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The production of Virgin Coconut Oil (VCO) or it is also known as the demulsification (emulsion breaking) of coconut milk is through the extraction of oil from an emulsion of coconut milk. A coconut milk emulsion consists of two immiscible liquids, which is coconut oil and water, with the coconut oil layers dispersed as small spherical droplets in the water layers in a continuous phase that cannot be separated easily (Friberg, 1997; as cited in Tangsuphoom and Coupland, 2009a). It means that coconut milk exist as a natural oil-in-water emulsions that is being extracted from the endosperm of mature coconut oil *(Cocos nucifera L.)*, either with or without the addition of water (Seow and Gwee, 1997; as cited in Marina et al., 2009a). The main components of coconut milk are water and fats, with carbohydrates, proteins and ash as minor components (Tansakul and Chaisawang, 2005).

On the other hand, one of the chemical property of coconut milk emulsions is the unfavourable contact between coconut oil droplets and water molecules and it

causes the emulsion exists thermodynamically unstable and readily separates into two distinct phases – a heavy aqueous phase and a lighter cream phase (Cancel, 1979; Gonzales, 1990; as cited in Nour et al., 2009). The reason behind this phenomenon is the protein contents and quality in coconut milk is not sufficient to stabilize the fat globules (Monera and del Rosario, 1982; as cited in Tangsuphoom and Coupland, 2009). However, the coconut milk emulsion is known to be naturally stabilized by coconut proteins – globulins, albumins and phospholipids (Birosel et al., 1963; as cited in Tangsuphoom and Coupland, 2008). Therefore, this concept can be apply in production of VCO, which is the coconut oil extracted from well matured and fresh coconut through specialized process without changing its natural nutrition as they were present in their original state in coconut milk emulsions.

In past, the conventional method used to produce VCO is via fermentation method. "Fermentation" is a natural separation of coconut oil from water by gravity separation. This involves splitting the nut, grating the meat to fine particle, squeezing the milk either manually or by mechanical means with or without water, and allowing the coconut milk to ferment for 36 to 48 hours. During this time, the heavier water will separates from coconut oil by sinking to the bottoms and discharged out, while the lighter coconut solids float to the top (curds). In between the coconut solids and water is a crystal clear coconut oil (cream) that is completely unrefined. The oil is then slightly heated (less than boiling temperatures) for a short time (5 to 15 minutes depending on the air temperatures) to remove any remaining moisture, and then filtered to further recovered some coconut oil. The result is a clear coconut oil that retains the distinct scent and taste of coconuts (Tropical Traditions Inc.).

As an engineer, we need to think based on 3Es – Environment, Economic and Engineering. As a result, the water soluble materials and centrifugation methods had been introduced in order to increase the yield of VCO and at the same time to reduce the production costs and time consuming in the production process.

Despite of this, the using of water soluble materials or hydrophilic chemicals is another method that has been applied in the demulsification of coconut milk to produce VCO in a shorter duration. By using a hydrophilic chemical, we can carry out the demulsification of coconut milk by damaging the bond of lipoprotein in emulsion (Nik Norulaini et al., 2009). Thus, it is very important to be precise and careful in choosing the type of chemicals that use in the separation process, make sure that the chemicals use is hydrophilic (attract to water phase) rather than lipophilic (attract to oil phase). This is due to the lipophilic chemicals will create environmental problems as well as various side effects on consumers health since VCO that is being extracted had been polluted by chemicals.

On the other hand, gravity separation is mainly associated with the slow creaming process of an oil-in-water immiscible mixture. A common way to accelerate this creaming process is by the use of centrifugation, where the high achievable rotation frequencies allowed an effective acceleration; highly superior to the simple gravitation case (Starobinets et al., 1979; Nour et al., 2009). Sometimes, gravity separation may be too slow because of closeness of the densities of the particles and the fluid, or because of association forces holding the components together (Nour et al., 2009). Gravity separation is time consuming, while centrifugal separation is accomplished in minutes (Geankoplis, 2003). The centrifuge works according to the sedimentation principle, where the centripetal acceleration is used to separate substance of greater and lesser density. By using centrifuge, it is possible to break down emulsions and to separate dispersions of fine liquid droplets; through in this case the suspended phase is in the form of liquid droplets, which will coalesce following separation of VCO from the water phase (Coulson and Richardson, 1991; as cited in Nour et al., 2009).

1.2 Problem Statement

One of the main reason that caused the highly demand of Virgin Coconut Oil (VCO) in market is due to its benefits to human being health. The facts are quoted below according to Tropical Traditions:

> *"VCO is the highest source of saturated medium chain triglycerides, MCT (62%). Furthermore around 50% of these MCT's are made up of lauric acid (C_{12}), the most important essential fatty acid in building and maintaining the body's immune system."*

Therefore, this research topic is purposed in order to find out a solution that are environmental friendly and can yield more production of VCO in a shorter time by using the water soluble materials and centrifugation method. At the same time, there is still room for improvement on the quality of VCO produced by using these two methods.

1.3 Research Objectives

As research was carrying out the on the production of Virgin Coconut Oil (VCO), there are a few objectives that need to be achieved throughout the experiment. The research objectives that are formulated and shown in below:

i. To investigate the separation and filtration of Virgin Coconut Oil (VCO) using water soluble materials and centrifugation method.

ii. To study the potentials of water soluble demulsifiers in demulsification (emulsion breaking) of Virgin Coconut Oil (VCO) emulsion.

With the help of the research objectives which act as a guideline throughout the research, a clearer target was set in order to achieve in the end of the research.

1.4 Scopes of Study

In this research, a new combination method in the production of Virgin Coconut Oil (VCO) was proposed, which is by water soluble material and centrifugation method. However, there are some limitations made in order to narrow down the area of field of study. The limitations of this research are as list down in below:

i. Characterization of oil and aqueous phase of Virgin Coconut Oil (VCO).
ii. Analyse the composition of Virgin Coconut Oil (VCO) using Gas Chromatography – Mass Spectrometer (GC-MS).
iii. Comparing the extraction yield that will be achieved when using water soluble materials and centrifugation method.
iv. Study the effect of extraction time for oil recovery.
v. Study the performance of water soluble materials and centrifugation method in extraction of virgin coconut oil (VCO) from coconut milk emulsion.
vi. Study the effect of alcohol on the performance of water soluble materials and centrifugation method in extraction of virgin coconut oil (VCO) from coconut milk emulsion.

1.5 Research Questions

In conducting this research, there are a few research questions aroused in this study and needed to be answer at the end of the research. These research questions are as shown below:

i. What is the separation and filtration efficiency of Virgin Coconut Oil (VCO) via water soluble materials and centrifugation method?
ii. What is the potentials water soluble demulsifiers in demulsification (emulsion breaking) of Virgin Coconut Oil (VCO)?

1.6 Rationale and Significance of Study

Virgin Coconut Oil (VCO) is growing in popularity as functional food oil and the public awareness of it is increasing. It is expected that the VCO will experience a dramatic growth in the market due to the finding from Arancon (2008); as cited in Henderson et al. (2010), the exports of VCO rose from nil in 2000 to almost 1131 metric tonnes in 2005 in Philipines. However, the conventional method – fermentation method used in production of VCO, is a time consuming process and will produce a lot of waste during the fermentation process. This will cause environmental problems like pollutions. Therefore, it is important to carry out a research in order to resolve this problem. In addition, a solution that can produce VCO in a more convenient and easy way should be formulated. Besides that, this research also aims to improve the quality of VCO extracted from coconut milk emulsions.